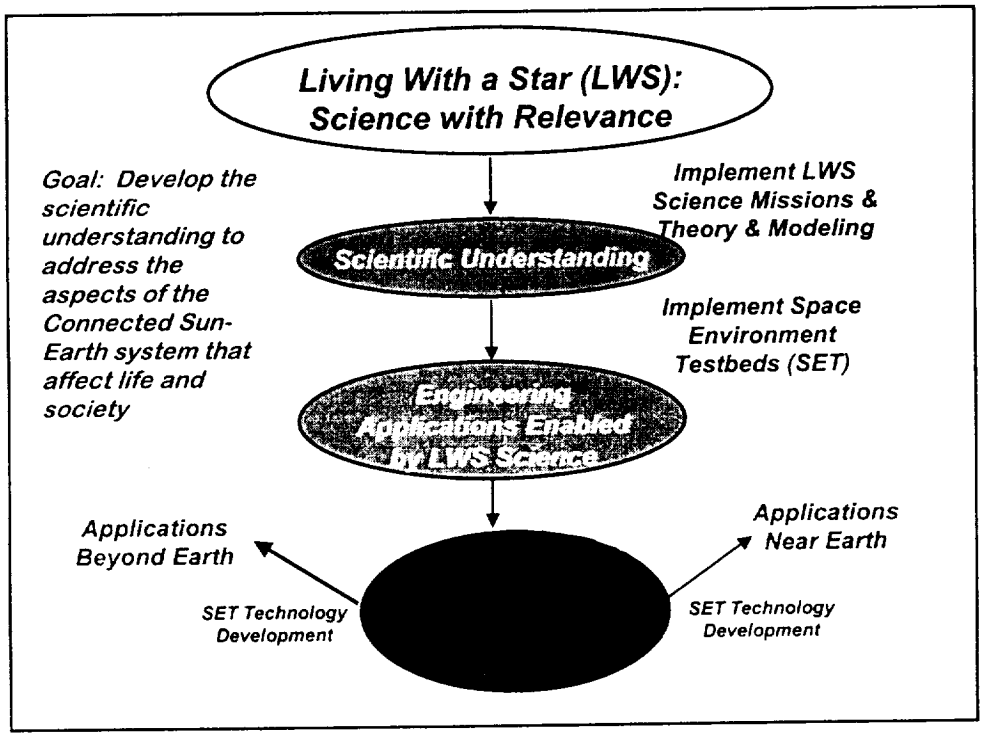
Space Environment & Effects Workshop
Marshall Space Flight Center
June 26-28, 2001

The Living with a Star Program
Space Environment Testbed

Janet Barth, NASA/GSFC
Discipline Scientist LWS/SET

THE SUN EARTH CONNECTION



The Sun & Earth Are a Connected System

Variable Star

Interacting

- *Magnetic fields*
- *Plasmas*
- *Energetic particles*

Varying

- *Radiation*
- *Solar wind*
- *Energetic particles*

Interacting

- *Solar wind*
- *Energetic particles*

Earth

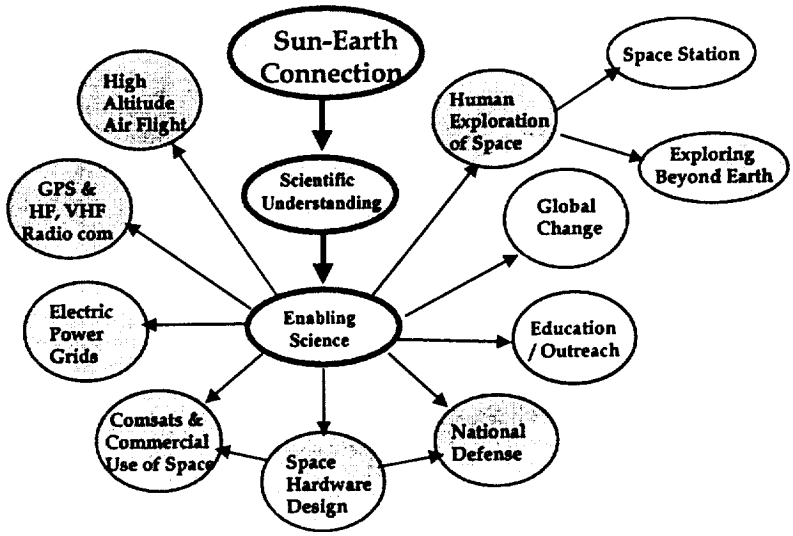
Interacting

- *Magnetic fields*
- *Atmosphere*
- *Plasma*
- *Energetic particles*

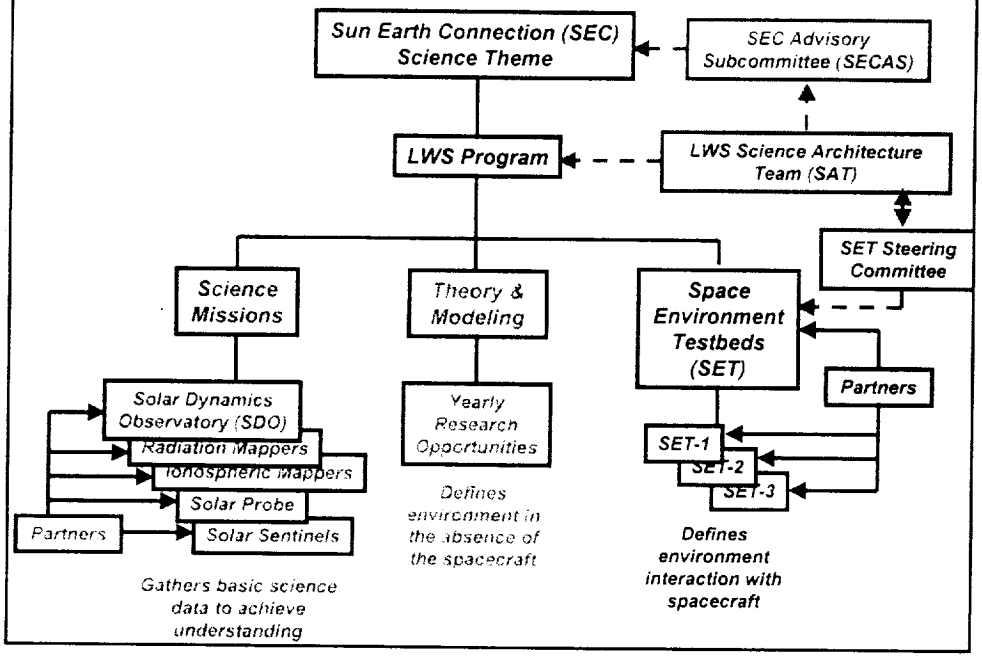
QUESTIONS:

- *How and why does the Sun vary?*
- *How do the Earth and planets respond?*
- *What are the impacts on humanity?*

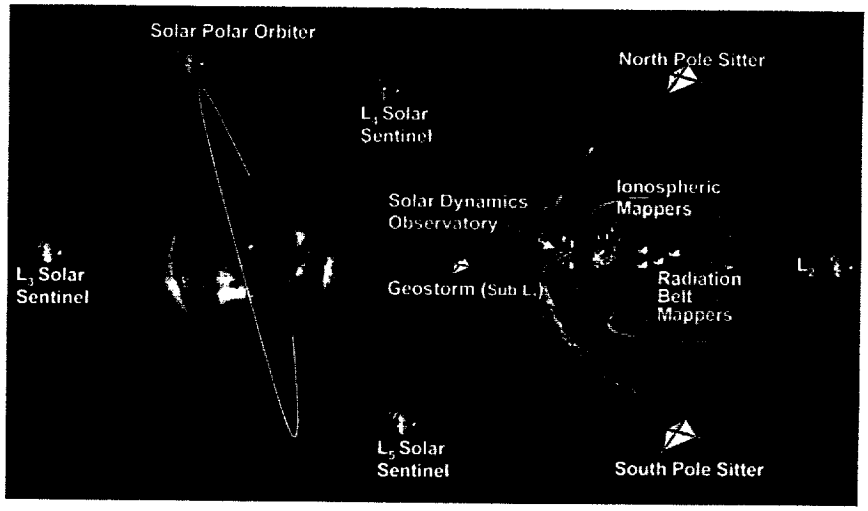
Sun Earth Connections



Living With a Star (LWS) Program Architecture



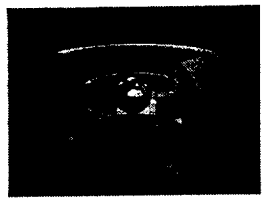
Living With a Star (LWS) Science Missions: A Network to Quantify the Sun-Earth Connected System



Living With a Star Theory & Modeling

Objective

Perform research to refine the understanding of space weather & the role of solar variability in terrestrial climate change



Approach

- *Improve understanding of space weather & solar variability*
- *Improve understanding of solar variability & its effect on long term climate change*
- *Perform research & development to enable improved environment specification models & predictive capability*

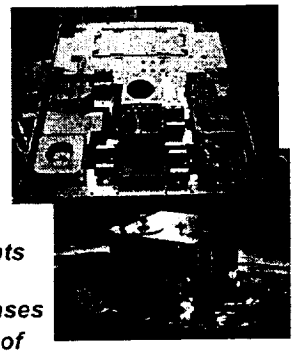
Scope

Solar atmosphere to Earth's ionosphere

Living With a Star Space Environment Testbeds

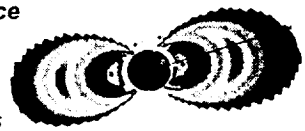
Objective

Improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design & operations



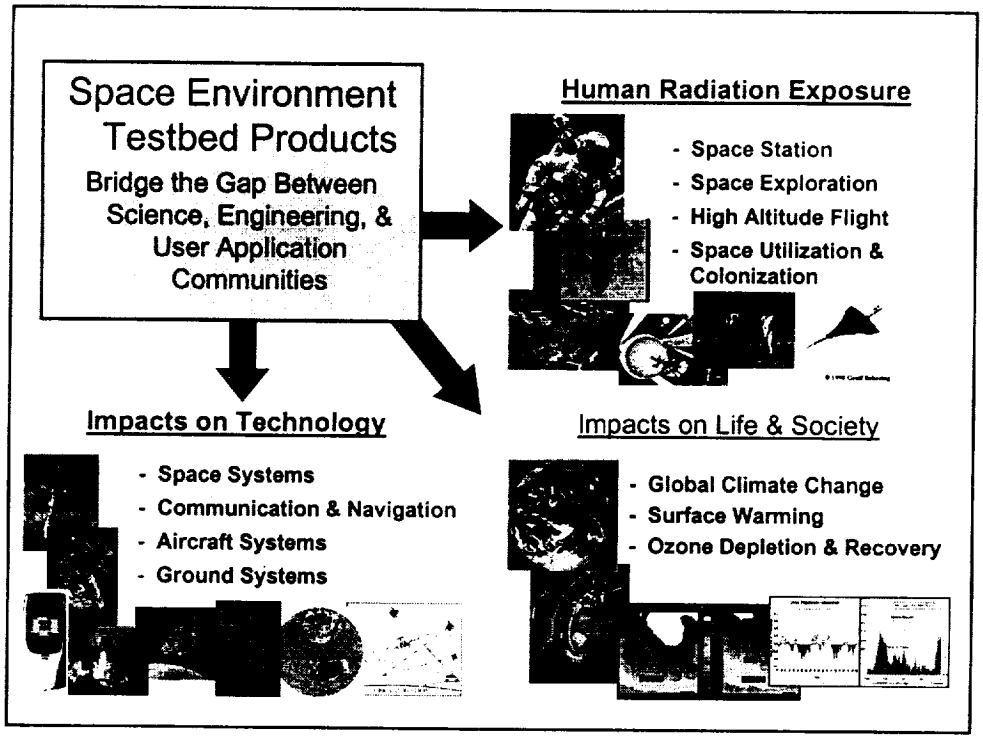
Approach

- *Collect data in space to validate new & existing ground test protocols for the effects of solar variability on emerging technologies & components*
- *Develop & validate engineering environment prediction & specification models, tools, & databases*
- *Collect data in space to validate the performance of instruments for LWS science missions & new space technology*



Scope

Spacecraft hardware & design /operations tools whose performance changes with solar variability



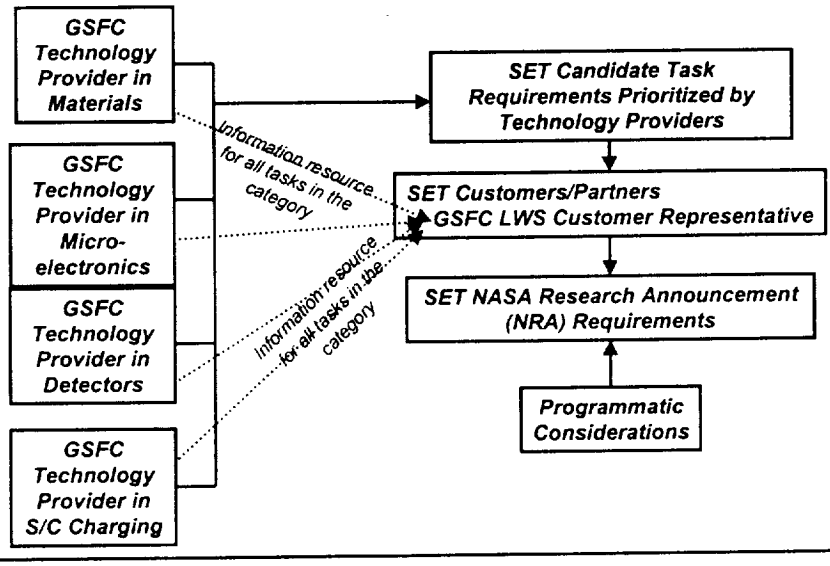
Program Status

- *LWS Funded Starting in FY01 as a continuous program*
- *Science Architecture Team (SAT) appointed by NASA/HQ*
  - *Meetings in November 2000, February & May 2001*
- *Solar Dynamics Observatory*
  - *Science Definition Team Formed*
  - *Launch Date – FY06*
- *NASA/HQ NRA in FY00 for Theory and Modeling*
- *Space Environment Testbed*
  - *Technology Provider Workshop in August 2000*
  - *Pre-NASA Research Announcement Workshop on January 25-26, 2001*
  - *LWS/SET Supplement to SEE Program NRA*
  - *NRA Announcement in November 2001 for experiments*
  - *Targeted Launch Dates*
    - *Missions of Opportunity – FY04*
    - *Full testbed – FY05*

How Do We Establish the Space Environment Testbed (SET) Program?

- Define the groundrules
  - Open competition with peer review
  - Establish & maintain partnerships
  - Establish customer/partner buy-in
- Provide background information in follow-on briefings at this workshop
- Define the requirements
  - Ask technology providers to develop and prioritize candidate SET task requirements at this workshop
    - Providers are organized by disciplines
  - Coordinate products from workshop with customers/partners to obtain customer priorities
  - Use customer priorities and programmatic considerations as requirements for the SET NASA Research Announcement (NRA)
- Provide opportunities to discuss potential partnerships in individual meetings

Example of Technology Provider and Customer Interfaces for the Space Environment Testbed Requirements



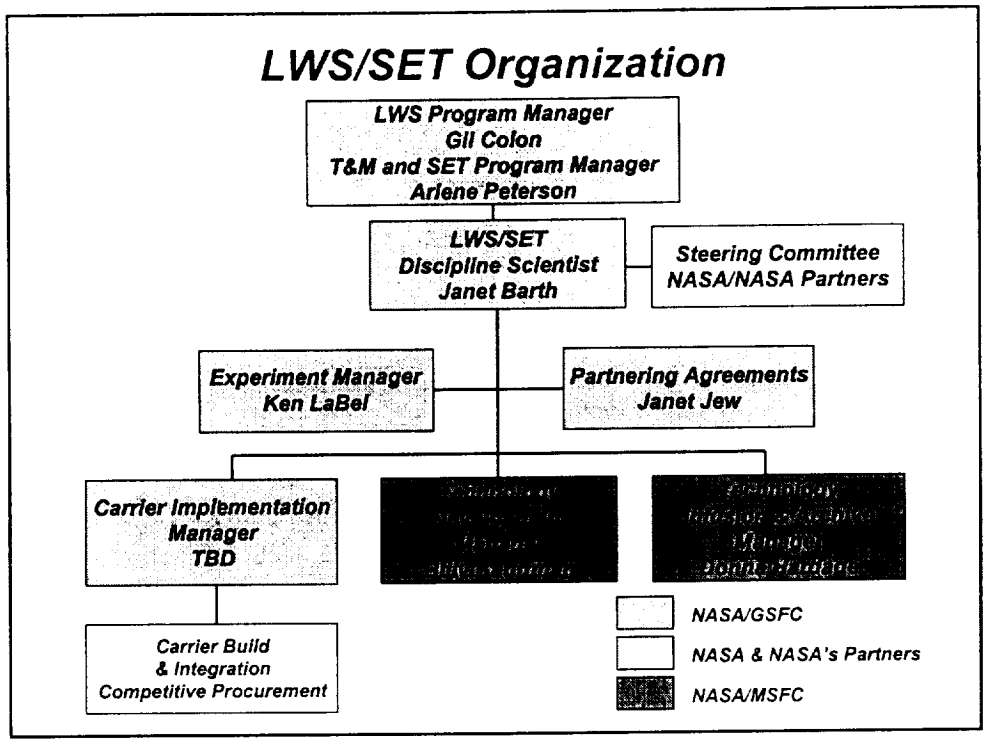
Objective

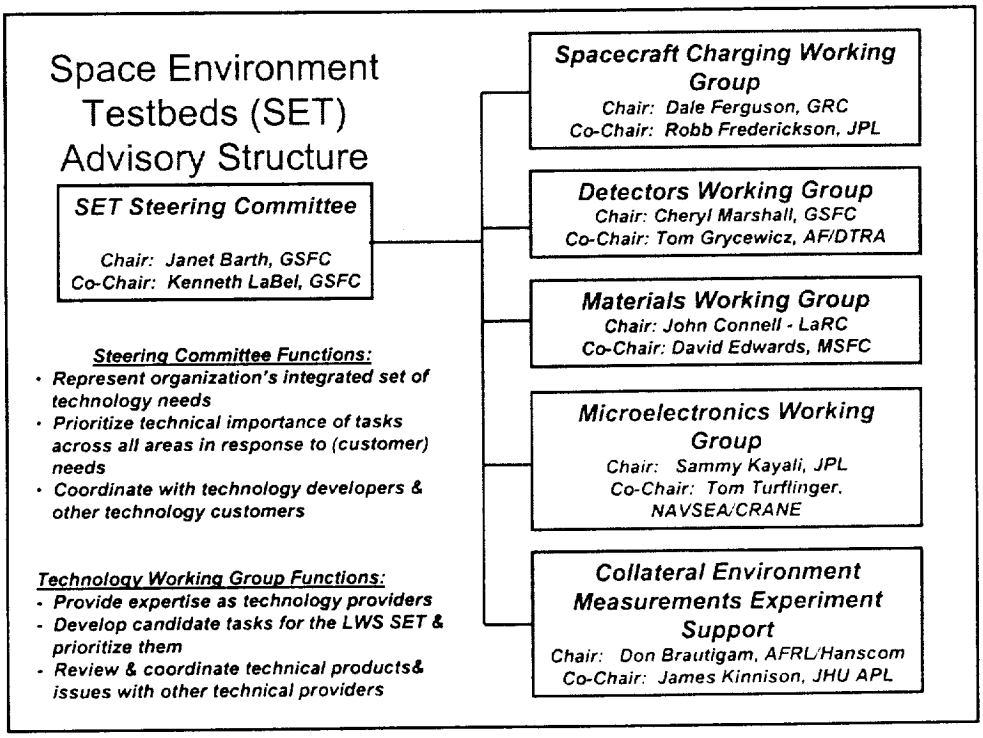
Improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design & operations

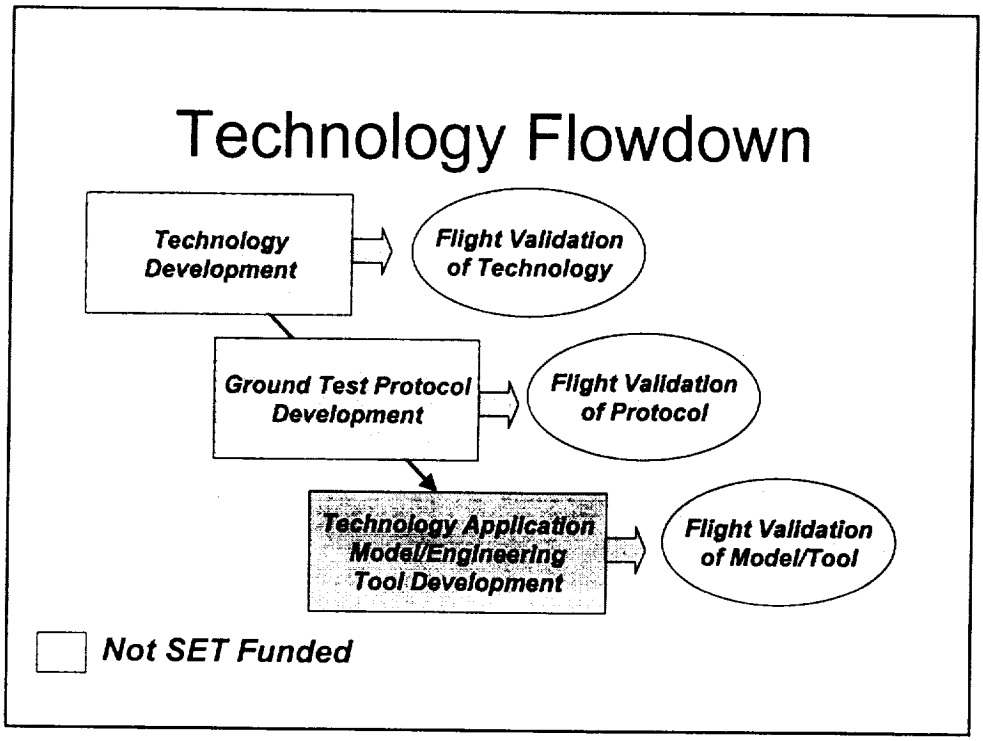
- *Systems must perform in complex Sun-Earth environments which vary with solar activity*
  - *Long term solar cycle*
  - *Events on the Sun*
- *Variable environments pose challenge for system developers*
  - *Design phase*
  - *Operational phase*
- *Engineering models, databases, guidelines are used to assure performance of systems*
  - *Inputs*
    - *Estimates of environment levels*
    - *Results of ground test protocols*
  - *Inaccuracy in Engineering Tools – Design Margins, Reliability Issues*
- *Large uncertainties in accommodation/mitigation techniques preclude reliable use of environmentally sensitive technologies*
- *Engineering tool development & validation efforts have not kept pace with technology changes*

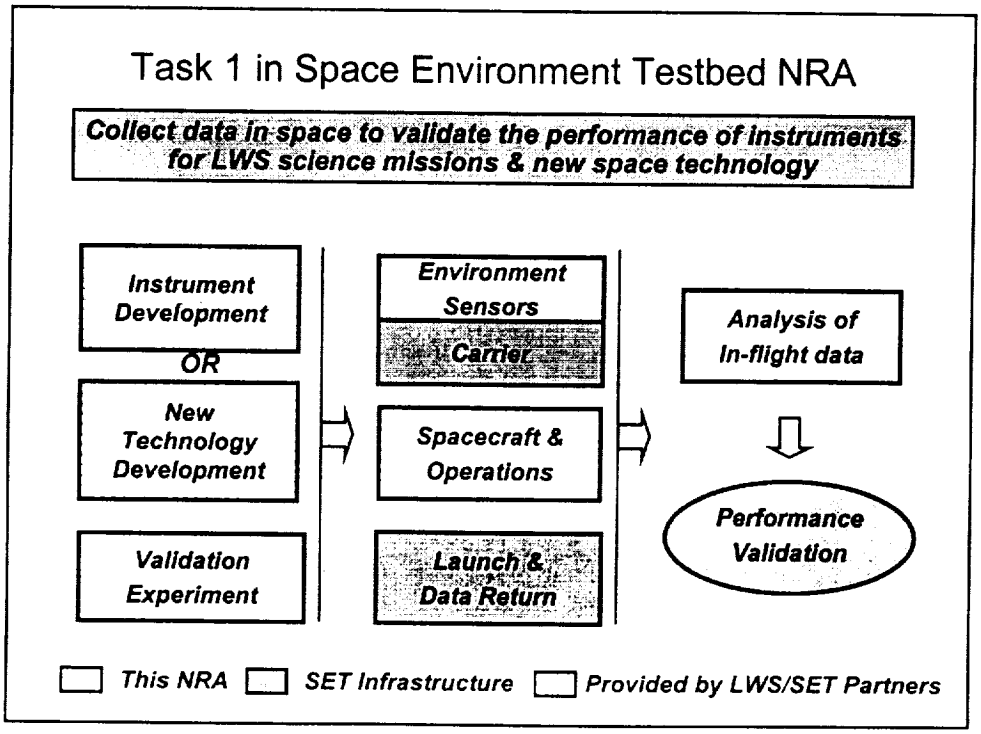
SET Implementation

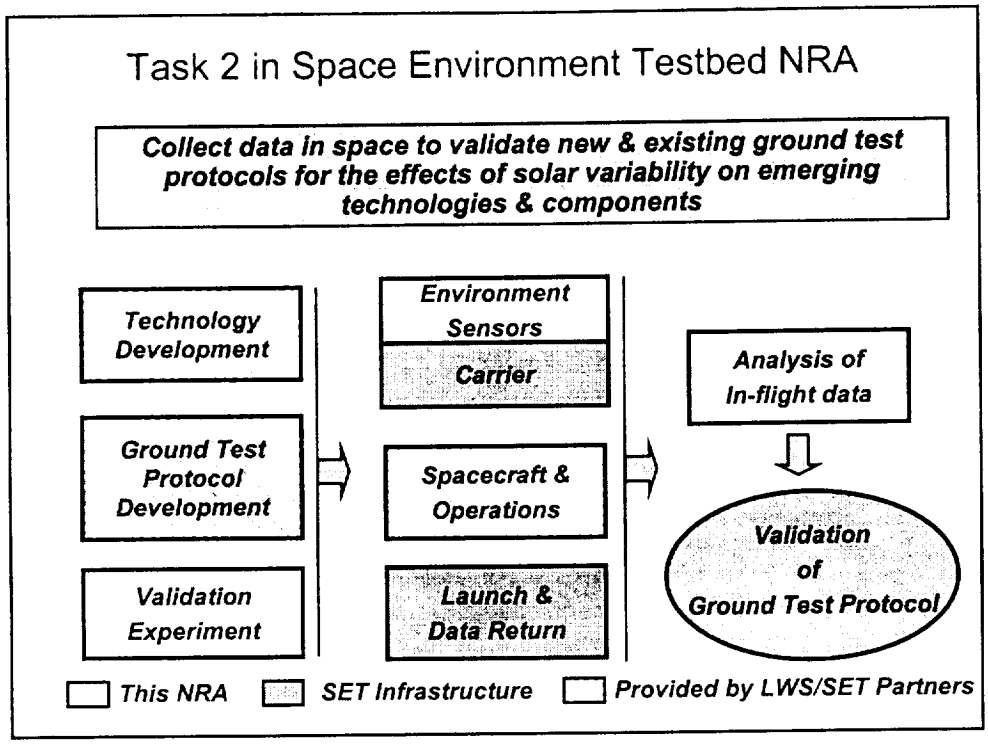
- *Establish Steering Committee*
- *Design modular carrier concepts to capitalize on launch opportunities*
- *Fly orbiting testbed every 2 years – First in late 2003 - early 2004*
- *Hold bi-yearly workshops*
  - *Requirements definition & partnering*
  - *Presentations of results*
- *Fund NASA Research Announcements*
  - *Technology Development*
    - *Database, Engineering Tools, Guidelines*
    - *Sensor development for tesbeds*
  - *Support for experiment build for technologies of interest to NASA/Industry*
  - *Analysis of testbed data/Data Mining*
  - *Validation of ground test protocols and prediction techniques*
- *First solicitation anticipated in February/March 2001*
- *Leverage off other programs*

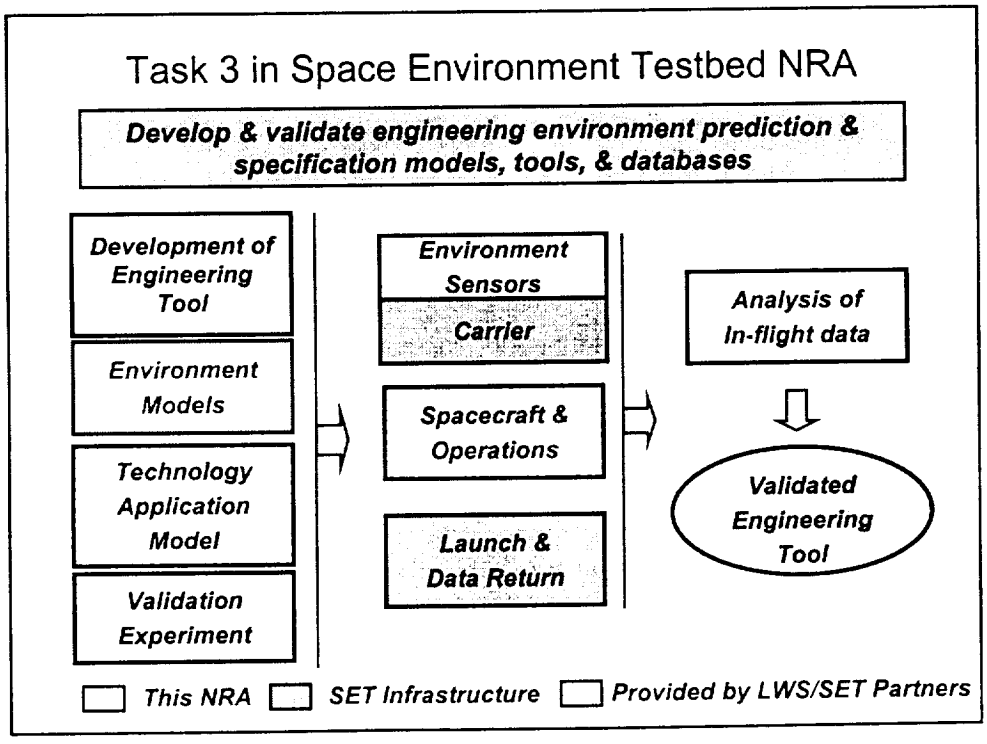

LWS/SET Organization
LWS Program Manager
Gil Colon
T&M and SET Program Manager
Arlene Peterson
LWS/SET
Discipline Scientist
Janet Barth
Steering Committee
NASA/NASA Partners
Experiment Manager
Ken LaBel
Partnering Agreements
Janet Jew
Carrier Implementation
Manager
TBD
Carrier Build
& Integration
Competitive Procurement
NASA/GSFC
NASA & NASA's Partners
NASA/MSFC


Space Environment
Testbeds (SET)
Advisory Structure
SET Steering Committee
Chair: Janet Barth, GSFC
Co-Chair: Kenneth LaBel, GSFC
Steering Committee Functions:
• Represent organization's integrated set of technology needs
• Prioritize technical importance of tasks across all areas in response to (customer) needs
• Coordinate with technology developers & other technology customers
Technology Working Group Functions:
- Provide expertise as technology providers
- Develop candidate tasks for the LWS SET & prioritize them
- Review & coordinate technical products& issues with other technical providers
Spacecraft Charging Working Group
Chair: Dale Ferguson, GRC
Co-Chair: Robb Frederickson, JPL
Detectors Working Group
Chair: Cheryl Marshall, GSFC
Co-Chair: Tom Grycewicz, AF/DTRA
Materials Working Group
Chair: John Connell - LaRC
Co-Chair: David Edwards, MSFC
Microelectronics Working Group
Chair: Sammy Kayali, JPL
Co-Chair: Tom Turflinger, NAVSEA/CRANE
Collateral Environment Measurements Experiment Support
Chair: Don Brautigam, AFRL/Hanscom
Co-Chair: James Kinnison, JHU APL


Technology Flowdown
Technology Development
Flight Validation of Technology
Ground Test Protocol Development
Flight Validation of Protocol
Technology Application Model/Engineering Tool Development
Flight Validation of Model/Tool
Not SET Funded


Task 1 in Space Environment Testbed NRA
Collect data in space to validate the performance of instruments for LWS science missions & new space technology
Instrument Development
OR
New Technology Development
Validation Experiment
Environment Sensors
Carrier
Spacecraft & Operations
Launch & Data Return
Analysis of In-flight data
Performance Validation
This NRA
SET Infrastructure
Provided by LWS/SET Partners

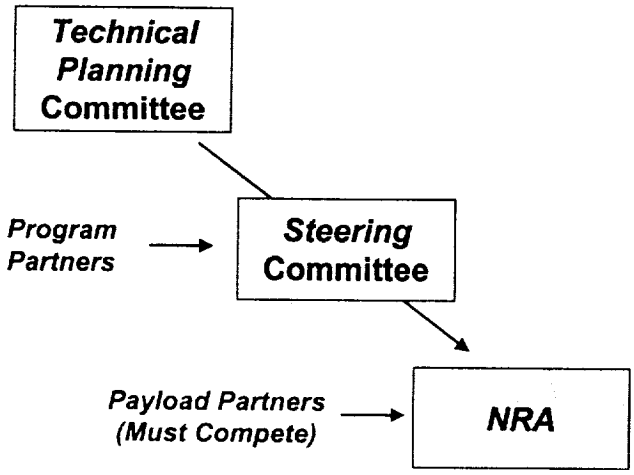

Task 2 in Space Environment Testbed NRA
Collect data in space to validate new & existing ground test protocols for the effects of solar variability on emerging technologies & components
Technology Development
Ground Test Protocol Development
Validation Experiment
Environment Sensors
Carrier
Spacecraft & Operations
Launch & Data Return
Analysis of In-flight data
Validation of Ground Test Protocol
This NRA
SET Infrastructure
Provided by LWS/SET Partners


Task 3 in Space Environment Testbed NRA
Develop & validate engineering environment prediction & specification models, tools, & databases
Development of Engineering Tool
Environment Models
Technology Application Model
Validation Experiment
Environment Sensors
Carrier
Spacecraft & Operations
Launch & Data Return
Analysis of In-flight data
Validated Engineering Tool
This NRA
SET Infrastructure
Provided by LWS/SET Partners

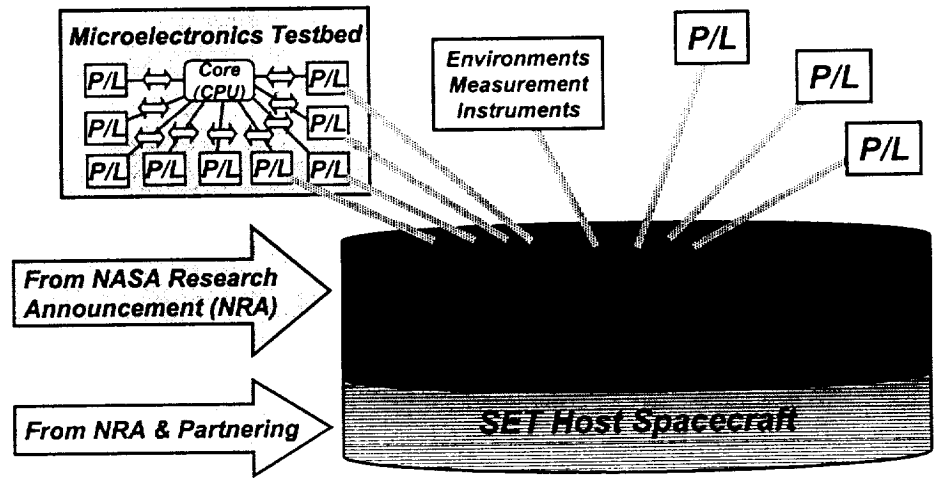
Three Options for Partnering

- *SET Partners: Partners contribute to the success of the LWS/SET Program*
  - *Agree on objectives and requirements*
  - *Participate in all Program aspects*
- *SET Carrier Partners: Partners contribute to the success of the Carrier*
  - *Retain separate requirements & objectives*
  - *Obtain allocation of spacecraft resources to achieve objectives*
- *Payload Partners: Partners contribute "payloads" in exchange for on-orbit operation, launch, & data return*
  - *"Payload" includes ground test data if appropriate, on-orbit data after reduction, & funding for integration and on-orbit operations*
    - *Variations in definitions of "payloads" are negotiable; "funding" can include in kind exchanges*

How to Partner



Space Environments Testbed (SET) Interface Requirements Concept



LWS/Space Environment Testbed

- Common support hardware and software to validate several sub-systems or components on orbit
  - Each mission will include a suite of appropriate environment sensors (space radiation, plasma, etc.) based on the technology experiment needs and launch constraints.
- NASA provides launch, on-orbit operation, and data return.
- Standard agreement with payload partners requires partners to provide ground test data, on-orbit data after reduction, and funding for integration.
- Partnering agreement is negotiable based on NASA interest and partner contribution to launch.

Appropriate Candidates for the LWS/SETs

SET Space Flight Candidates:

- *Technology that requires space flight for performance characterization or validation*
- *Technology candidates applicable to more than one mission or to a LWS mission*
- *Technology whose performance changes due to the effects of solar variability*
  - *Performance changes cannot be minimized by changing the spacecraft design*

SET Data Analysis Candidates:

- *Data that describe performance variations in space in the presence of a spacecraft that changes due to solar variability*